

BEFORE THE  
FEDERAL COMMUNICATIONS COMMISSION  
WASHINGTON, D.C. 20554

In the Matter of	)	
	)	
2000 Biennial Regulatory Review --	)	IB Docket No. 00-248
Streamlining and Other Revisions of	)	
Part 25 of the Commission's Rules	)	
Governing the Licensing of, and	)	
Spectrum Usage by, Satellite Network	)	
Earth Stations and Space Stations	)	

**COMMENTS OF QUALCOMM Incorporated**

QUALCOMM Incorporated ("QUALCOMM"), pursuant to Section 1.405 of the Commission's Rules and Regulations, respectfully submits these comments in response to the Commission's Further Notice of Proposed Rule Making ("FNPRM"), IB Docket No. 00-248, released September 26, 2002.

QUALCOMM's submission focuses on the Commission's request for comments concerning revisions to its rules applicable to the licensing of earth stations, including those applicable to the routine processing of earth stations meeting certain technical requirements. QUALCOMM agrees with the Commission that it is important to address issues relating to the statistical properties of satellite multiple access systems, particularly where multiple small earth stations operate within a network or group of networks. Our comments will discuss the nature of the rules that should be adopted with respect to random access and multiple access techniques employed by very small aperture terminals (VSAT) (and related) networks. In particular, QUALCOMM addresses the need to adopt regulations, which accommodate state-of-the-art technologies used or to be used by earth stations in conjunction with Fixed Satellite Service (FSS) systems for the establishment of large area, broadband networks. QUALCOMM believes that our proposals will provide the Commission with an alternative approach towards regulating FSS systems that will enable the Commission to achieve its goals of establishing clear and consistent rules, while simultaneously providing sufficient flexibility to encourage the deployment of new, innovative technologies and services.

QUALCOMM is a world leader in developing, delivering, and enabling innovative digital wireless communications products and services based on its digital technologies. QUALCOMM is dedicated to growing the wireless industry through technology licensing, chipsets and system software, satellite-based systems, and new innovations in wireless data products and applications. QUALCOMM's code division multiple access ("CDMA") technology has been licensed to more than 95 leading communications manufacturers worldwide. Due to its unsurpassed voice quality, system capacity, privacy and flexibility, CDMA is the recognized global standard for next-generation, digital wireless communications products and services.

QUALCOMM below provides our views on the potential for adjacent satellite interference from VSAT, or VSAT-like, terminals resulting from various satellite multiplexing schemes currently in use and likely to be used by service providers in the near future. Although our comments and proposal for a new statistical approach will focus on terminals using the Ka-band, the approach presented may be equally applicable to C-band or Ku-band terminals.

A key objective of the Commission's regulations governing transmitting earth stations is avoidance of unacceptable interference from an earth station to satellites adjacent to the one with which the earth station is operating. Consequently, the Commission's rules set forth specific off-axis EIRP spectral density limits. The rules provide separate limits for earth stations in the Ka-band for which applications can be routinely processed (Sec. 25.138 (a)) and provide a process for applications in which the earth station's off-axis EIRP spectral density limit exceeds what the Commission has defined for routine or blanket licensing (Sec. 25. 138(b)). These rules currently provide for a difference in calculation of the EIRP spectral density depending on whether a CDMA, or TDMA or FDMA access scheme is utilized.

In this proceeding, however, the Commission asks for comments on specific proposals (See Aloha Network Comments at 5-6 and Reply Comments at 2) to utilize a different metric for systems in which more than one earth station may be transmitting on the same frequency at the same time. The Commission recognizes the possibility of simultaneous transmissions, which may result in power levels exceeding those specified in the Commission's rules for very limited periods of time (tens of milliseconds). (FNPRM at §77). Thus, the Commission states its view, "that a more general and simplified approach addressing several random access techniques would better facilitate the licensing of earth stations" than a rule limited to slotted Aloha techniques that had previously been proposed by various parties. (FNPRM at §79). The

Commission also recognizes that some of its previous proposals, e.g., requiring a reduction in VSAT PFD by 3dB when two or more terminals transmit simultaneously in the same frequency band, would be excessive and not necessary to avoid unacceptable interference to adjacent satellites. (FNPRM at §81).

QUALCOMM believes that a statistical approach, rather than those proposed in the FNPRM, would best meet the Commission's objectives of ensuring that earth stations do not cause unacceptable interference while enabling the introduction of new technologies without the need for further rule changes. In this regard, QUALCOMM has developed a set of Cumulative Distribution Functions (CDFs) that we propose as the basis of a new, effective regulatory scheme for all FSS small terminal users. By using statistical methods of specifying adjacent satellite EIRP spectral density (ESD), the Commission can balance regulatory oversight with operational flexibility for satellite operators. QUALCOMM believes that it is possible to adopt a set of regulations that addresses control of off-axis emissions for all classes of user terminals, for all service categories, and for all modulation and multiplexing methods. By appropriately applying a family of CDF-based regulations, distinctions need not be made on the basis of frequency bands, service categories, or access techniques. Such an approach would be technology neutral and should spur innovation in development of satellite earth stations as well as the implementation of satellite systems, which can provide two-way Internet access.

As is described in greater detail below, QUALCOMM-designed systems feature terminals with dynamic properties. Increasingly, many terrestrial and satellite systems will employ such properties. This premise was recognized by the Commission's Spectrum Policy Task Force when it made the case for evolution to spectrum policies that reflect the changing nature of spectrum use (See Spectrum Policy Task Force Report, ET Docket No. 02-135, November 2002). As technologies become more dynamic, interference management will become more difficult. The Task Force recognized that, in this new environment, spectrum policies must reflect the dynamic and innovative nature of spectrum use. (Task Force Report, p. 13). The statistical approach proposed by QUALCOMM is entirely consistent with this effort to evolve from a restrictive regime to one where the introduction of dynamic and innovative technologies is more likely. Moreover, the QUALCOMM statistical approach advances the Task Force goals of providing greater regulatory certainty, while minimizing regulatory interventions and adopting more flexible and market-oriented regulatory models. Finally, use of this statistical

approach will increase the efficiency of the Commissions application processing procedures, adding to the likelihood of “increased opportunities for technologically innovative and economically efficient spectrum use.” (Task Force Report, p. 3).

The benefits of employing a statistical approach can be demonstrated using CDMA as an example multiplexing method for broadband Ka-band systems. The current Part 25.138(a)(1) specifies an allowable off-axis EIRP spectral density from Earth stations into adjacent satellites positioned along the GEO arc in terms of the equation:

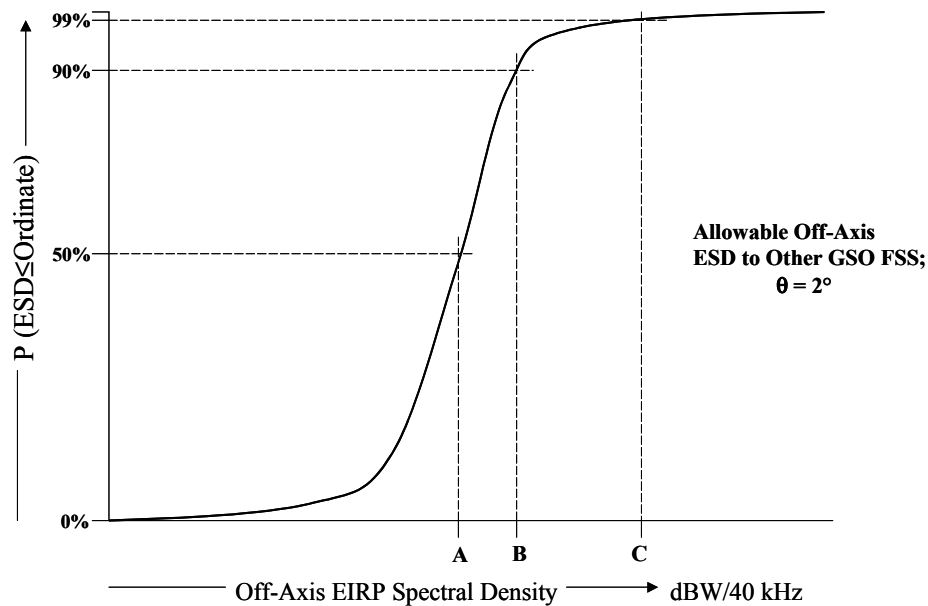
$$\text{Max. ESD} = 18.5 - 25\log(\theta) - \mathbf{10\log(N)}.$$

The last term of the equation, **10 log (N)**, is intended to account for the likely maximum number of simultaneously transmitting co-frequency earth terminals. This portion of the equation seems to apply directly to CDMA systems; however, other system multiplexing schemes may be envisioned where channel power is shared. Regardless of how broadly the rule is interpreted, this term implicitly assumes that all users sharing the channel have equal status (meaning that they are transmitting at the same power levels or at the same time) and that N of them exist. In contemporary systems being designed for broadband service, this assumption of equality in power and bandwidth is not, in general, a valid assumption. Two examples support this view:

- 1) Not all stations sharing the channel may use the same class of spreading code. The use of higher order orthogonal codes within the system allows stations with quite disparate actual data rates to be sharing the same physical channel. As such, stations with different rates will be simultaneously transmitting at different power levels. This situation can be sufficiently dynamic to suggest that a statistical treatment of channel occupancy would be a better approach to describing the co-channel power condition and the allocation of adjacent satellite interference.
- 2) Not all stations sharing the channel and assigned to transmit on a given code and at a given spectral rate may actually be transmitting at any given time period. That is, some terminals may be driven in their transmission schedule by, for example, latency effects dictated by the particular broadband network application (e.g. Internet delays or queue-related effects). This behavior is most clearly statistical and some benefit may be gained from code channel over-subscription as detailed modeling shows.

Both of these statistical artifacts of such a system argue that the best way of expressing the instantaneous uplink power of the system (and consequently the total off-axis ESD) is by treating the issue statistically and by developing an appropriate CDF to regulate interference.

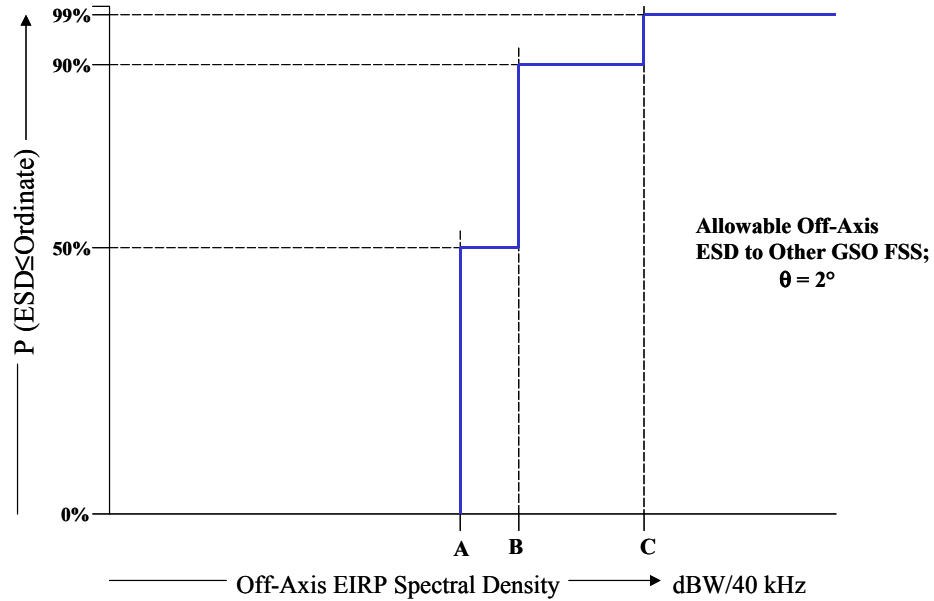
Given that most contemporary systems, both terrestrial and satellite, employ terminals with dynamic properties where power output varies *and* the number of terminals transmitting at any given instant is a random variable, QUALCOMM believes that the best way to express the emission characteristics of the network of terminals is by means of its cumulative distribution function or CDF. Figure 1 is an example of a notional CDF applicable to this condition.



**Figure 1: Notional Cumulative Distribution Function**

Such a power distribution could exist for a particular network of terminals. In this case the ordinate value is the ESD for the sum of all VSAT terminals in the satellite receiver beam in question. The relationship expresses the percentage of time the power will be less than or equal to a particular value given on the X-axis of the plot. This method of specifying allowable off-axis power takes into account the realities of random access systems without having to address the issue of collisions or other artifacts that are not relevant to the regulatory treatment of the network or its individual terminals. A specific CDF of this type, however, is still not sufficiently general to allow a single statistical condition to be applied across all multiplexing techniques.

To accomplish this, QUALCOMM proposes to use a CDF “Allowance Mask” as shown in Figure 2.



**Figure 2: CDF Allowance Mask**

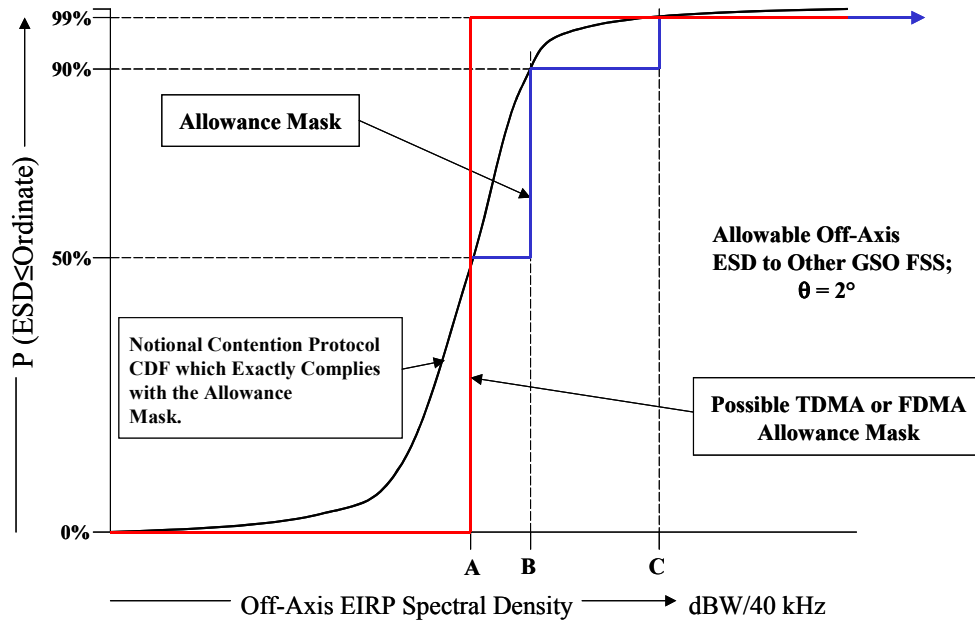
A written interpretation of Figure 2 can be stated as: for a given satellite network (and within a given satellite receiver beam) the terminals sharing a given frequency channel must have a combined ESD of  $\leq A$  dBW/40 kHz for 50% of all time. The same terminals must also have a combined ESD  $\leq B$  dBW/40 kHz for 90% of the time. And again, the same terminals must have a combined ESD  $\leq C$  dBW/40 kHz for 99% of the time. Expressing the last condition another way, the same terminals may have a combined ESD of (greater than C dBW/40 kHz) for only 1% of the time.

In principle, all methods of signal multiplexing could take advantage of this type of statistical requirement. An FDMA system could take advantage of the CDF by adjusting one or all of the power levels of the terminals within a group of channels to comply with the CDF. This, however, may result in an increased adjacent channel interference condition, depending on how the network was implemented. The statistical condition adopted would probably benefit from an ESD requirement specified in terms of a wider bandwidth (for example units such as dBW/1.0 MHz).

A TDMA system could change the utilization statistics of its time slots so that higher data rate users could obtain a larger number of consecutive slots (as only one example, given here) so

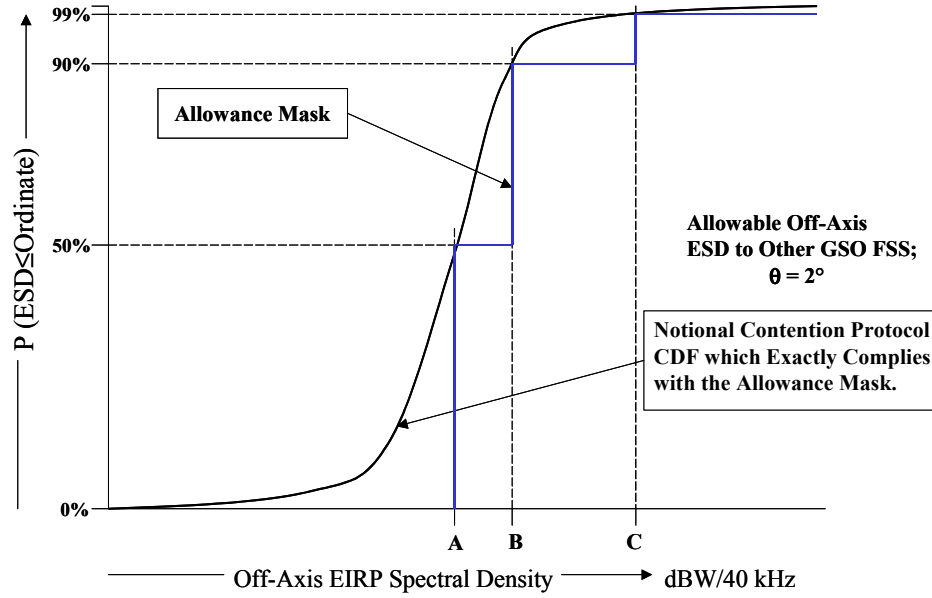
as to conform to the overall Allowance Mask. Some time slots would not be occupied in order for conformance with the CDF to be achieved. CDMA users would increase the number codes active during a specific time interval to satisfy higher traffic demands on a dynamic basis.

There is an alternative, of course, for both TDMA and FDMA system to use the more conventional approach as shown in Figure 3. In this instance, the output of the network is constant all of the time the channels are occupied.



**Figure 3: Application of the Allowance Mask for FDMA or TDMA**

For CDMA, however, other methods are available. Users of random access techniques involving contention protocols could easily implement the CDF so that the statistics of their user network population matched those of the adopted CDF Allowance Mask (as we show here, by example, in Figure 4).

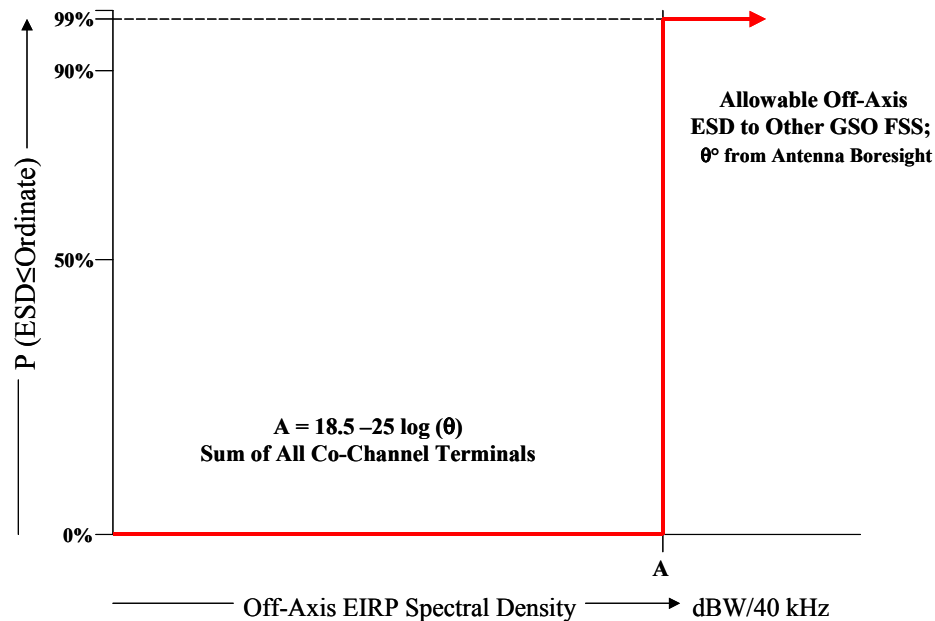


**Figure 4: Application of the Allowance Mask to a Notional Contention Protocol CDF**

As we have outlined above, it is inappropriate to specify off-axis ESD on a per terminal basis. Because of the many statistical processes concurrently affecting the system, it is system-level ESD that should be addressed by regulation. And, only a method such as a CDF is appropriate for describing the interference power into other systems. This necessarily means that in order to “routinely process” a class of user terminals, a total system showing should be made by an operator to the FCC, and the description of a given terminal’s off-axis interference is subservient to that of the overall system description.

As a means of accomplishing the Commission’s specific objectives discussed in the FNPRM, QUALCOMM proposes the use of a CDF “Allowance Mask” as shown in Figure 5. This is the simplest form of CDF that could be used; yet it should satisfy the FCC’s existing requirements and meet the proposed 0.01 probability of transmission collision suggested in the FNPRM.





**Figure 5: Proposed Cumulative Distribution Function**

In addition to a regulation limiting VSAT inbound uplink ESD, QUALCOMM agrees that it is necessary to regulate the angle-dependent gain (such as Part 25.209) of each terminal for the purposes of preventing interference from and to other *terrestrial* services sharing the frequency bands.

In conclusion, QUALCOMM would like to thank the Commission for the opportunity to share our views on how adopting a statistical approach in its rules on licensing of earth stations would best meet the Commission's objectives of ensuring that earth stations do not cause unacceptable interference while enabling the introduction of new technologies without the need for further rule changes.

Respectfully submitted,  
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